

## PRELIMINARY LOADING ANALYSIS

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*Prepared for*



CALFED Water Quality Action Team  
Sacramento, CA

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CONSTITUENT SELECTION TABLE											
Ecological/ Human Health											
Type	Constituent	303(d) List Problem Area	303(d) List Solution Area		303(d) List Affecting Problem Area		Drinking Water	Agricultural Water	Industrial	Recreational	LOADING LIST
		Delta	Sacramento Basin	San Joaquin Basin	Bay Region	Sacramento R. (above dams)					
Metals	As										
	Ca										
	Cl										
	Cu*										
	Hg*										
	Pb										
	Ni										
	Zn										
Trace El.	selenium*										
	boron										
Organics	TOC										
	DOC										
	THM										
	THMFP										
	TFPC										
	11/25/4										
Pesticides	DDT										
	carbofuran*										
	chlordane (A)										
	chlorpyrifos*										
	diazinon*										
	toxaphene (A)										
	PCBs										
	endosulfan (A)										
Salts	TDS										
	salinity										
	SAR										
	bromide										
	chloride										
Biotic	pathogens*										
	viruses*										
Nutrients	nitrate*										
	phosphorous										
	ammonia*										
Other	DO*										
	turbidity										
	temperature										
	unk. toxicity										
	pH										
	alkalinity										
	sediment										
*Initial constituents for loading analysis											

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SOURCE SELECTION TABLE											
Type	Constituent	Agricultural	Mine Drainage	M&I Wastewater (POTW)	Urban Runoff	Flow Regulation	Dams	Dairies	Construction	On-site Disposal	Marinas
Metals	As										
	Cd										
	Cr										
	Cu										
	Hg										
	Pb										
	Ni										
	Zn										
Trace El.	selenium										
	boron										
Organics	TOC										
	DOC										
	THM										
	THMFP										
	TFPC										
	chlorpyrifos										
Pesticides	DOT										
	carbofuran										
	chlordane (A)										
	diazinon										
	toxaphene (A)										
	PCBs										
	endosulfan (A)										
Salts	TDS										
	salinity										
	SAR										
	bromide										
Biotic	chloride										
	pathogens										
Nutrients	viruses										
	nitrate										
Other	phosphorous										
	ammonia										
	DO										
Other	turbidity										
	temperature										
	unk. toxicity										
	pH										
	alkalinity										
	sediment.										

COPPER LOADING TABLE										
	Copper Loading (thousands of pounds/year)									
Source	Delta	REF	Sacramento Basin	REF	San Joaquin Basin	REF	Bay Region	REF	Sacramento River above Dams	REF
Agricultural	B		33	1a	B					
Mine Drainage			139	1a	4	1a				
M&I Wastewater (POTW)	B		6	1a	A		A			
Urban Runoff	2	1c	18	1a	0.2	1e,1f	8	1c		
Flow Regulation										
Dams									56	1a, 2
Total	2		196		4.2		8		56	

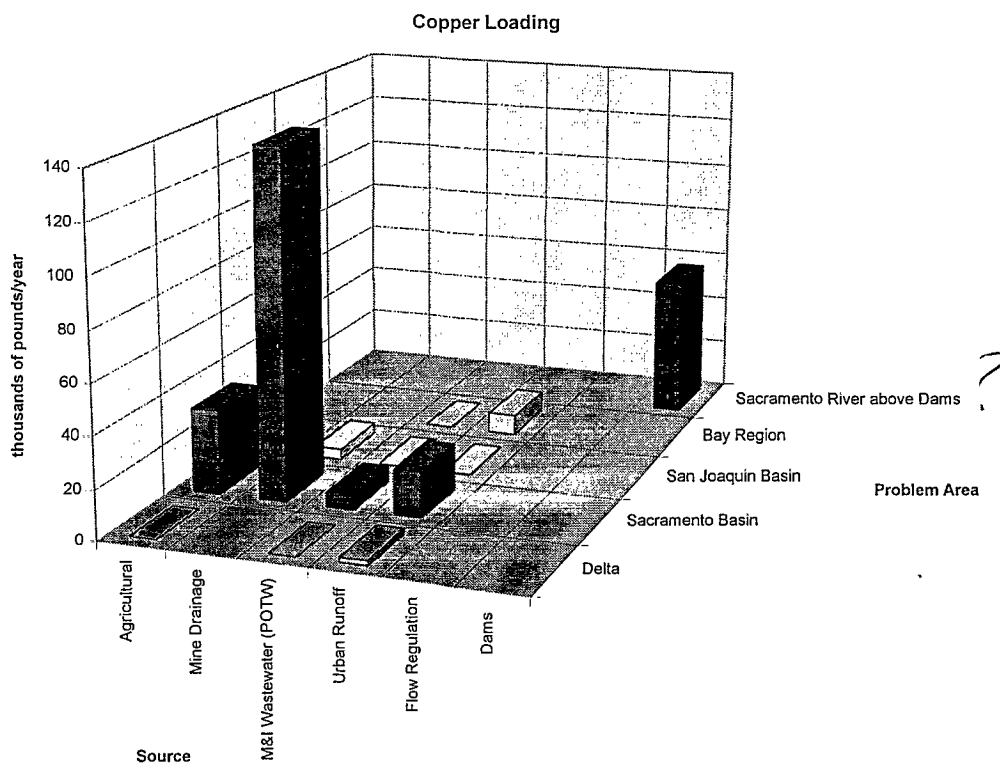
1a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

A - Data Available (Flow and concentration data available. Requires load calculation)

B - Further literature review required.

2 - Shasta, Oroville, and Nimbus dam releases

- Source does not contribute significant load of constituent in this watershed.



## Copper Reference List

**1a.** Central Valley Regional Water Quality. March 1989. Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in Sacramento Valley, CA. Draft Staff Report.

### Assumptions/Methodology

- Flow-volumes and concentration data used to calculate loads.
- Average historical data used when 1985-specific data not available.
- Data for discharges below major dam structures.

#### 1. Agricultural Drainage

- Delta and San Joaquin agriculture excluded from the estimates.
- Loads calculated separately for rice season (may-June) and the rest of the year to reflect concentration differential from seasonal growing practices.
- Background loads were not subtracted out.

#### 2. Urban Runoff

- Estimated from six major cities in Sacramento Valley.
- Runoff coefficient of 0.3, city-specific rainfall, concentration data and average summer flow were combined for a conservative estimate of flows.

#### 3. Municipal/Industrial

- Monitoring data from Sacramento Valley NPDES dischargers was compiled.

#### 4. Mine Drainage

- Loads estimated from Iron Mountain and Afterthought Mines in northern Sacramento Valley.
- Mine drainage is less than 1% of outflow, however contributed majority of cadmium, copper, and zinc (81%, 71%, and 84% respectively).

#### 5. Dams

- Calculated from Shasta, Oroville and Nimbus Dam releases during 1985.
- $\text{load} = \text{dam release} * \text{average metal concentration}$ .

## **Copper Reference List**

**1b.** Central Valley Regional Water Quality Control Board. March 1989. Mass Loading Assessment of Major Point and Non-Point Sources Discharging to Surface Waters in Sacramento Valley, CA. Draft Staff Report.

- Loads (Loads are the same as those calculated in Study 1a) were recalculated to account for portion of each discharge type not included.
- NPDES dischargers doubled to account for exclusion of 50% of total Sacramento Valley Outflows.
- Agricultural drainage was adjusted based on the assumption that approximately 80% of outflows were included.
- Urban load 35% of actual load.
- Mine load 25% of actual load.

**1c.** Contra Costa Clean Water Program. 1994. Contra Costa Clean Water Program Loads Assessment Report.

- Calculated copper and nitrate loads using parcel data and runoff coefficient for each land use.

**1d.** San Francisco Estuary Institute. Regional Monitoring Program for Trace Substances: 1995 Annual Report.

- Annual Reports published for 1993 and 1994.
- Sampled 24 stations from Sacramento/San Joaquin inflow to South Bay sloughs. Three sampling events for each year peak winter flow, spring declining flow and summer low flow.
- Near -total copper in water for 24 stations.
- Station transect runs from San Joaquin/Sacramento inflow to South Bay.
- Concentration data only. Loads could be calculated. Discharge data for Sacramento River, San Joaquin River, Petaluma River, Napa River, and Coyote Creek needs to be compiled.

**1e.** City of Modesto. May 1993. Part 2 NPDES Storm Water Permit Application.

- Method used to calculate loads is analogous to the "simple method" described in November 1992 EPA Guidance Manual for the Preparation of NPDES Permit application form Municipal Separate Storm Sewers.

**1f.** Fresno-Clovis Storm Water Quality Management Program. April 1995. Estimate of Annual Pollutant Loads to Waters of the United States.

- Method used to calculate loads was derived from the "simple method".

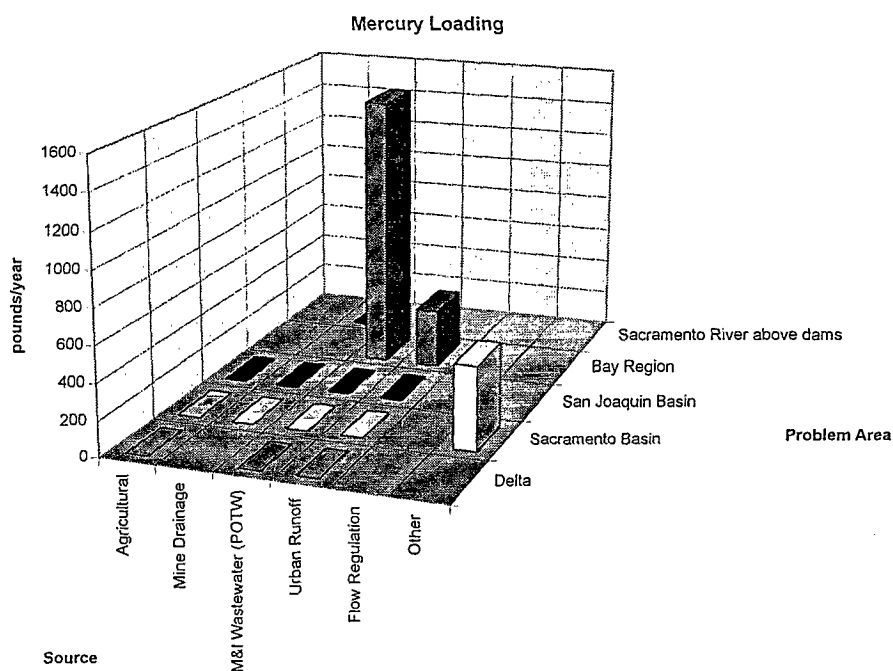
MERCURY LOADING TABLE										
	Mercury Loading (pounds/year)									
Source	Delta	REF	Sacramento Basin	REF	San Joaquin Basin	REF	Bay Region	REF	Sacramento River above dams	REF
Agricultural	B		B		B					
Mine Drainage			B		B				B	
M&I Wastewater (POTW)	B		B		B		1543	2a		
Urban Runoff	B		B		B		330	2a		
Flow Regulation										
Other			463	2d						
Total			463				1873			

2a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

A - Data Available (Flow and concentration data available. Requires load calculation)

B - Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



## Mercury Loads Study Reference List

**2a.** Association of Bay Area Governments, 1992. San Francisco Estuary Project State of the Estuary: A Report on Conditions and Problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. June (Table 19, pp. 172)

Note: Data from Table 19 was adapted from Davis et al., 1991.

- value for M&I Wastewater (POTW) is reported as 0.2-0.7 metric tons/year. Highest loading data is used for this purpose.
- value for Urban Runoff is reported as 0.026-0.15 metric tons/year. Highest loading value is used for this purpose.

**2b.** "Inactive Mine Drainage in the Sacramento Valley, California" by the CRWQCB, Central Valley Region reports mercury in dry weight concentrations (July 1992).

- The report states "the inter-and intra-mine site variability made runoff loading predictions very difficult. However, the high metal content of most waste rock material indicates site runoff loading can pose a substantial water quality threat.(pp.20) Sites where mercury mines were located were dry during the study period therefore no loadings were reported.

**2c.** "Contra Costa Clean Water Program FY 1994-95 Monitoring Report"

- reports Mercury concentrations (ug/l) in stormwater runoff.

**2d.** Sacramento Regional Sanitation District. March 1997. Sacramento River Mercury Control Project.

- Estimated mercury loads for Sacramento River, Feather River, American River, Sacramento Water Treatment Plant, Yuba River, and Bear River.

**2e.** San Francisco Estuary Institute. Regional Monitoring Program for Trace Substances: 1995 Annual Report.

- Annual Reports published for 1993 and 1994.
- Total Selenium in Water Reported for 24 stations.
- Locations of stations include San Joaquin/Sacramento inflow to South Bay
- Concentration data only.



SELENIUM LOADING TABLE

Source	Selenium Loading (hundreds of pounds/year)									
	Bay Region	REF	Contra Costa	REF	Stanislaus River	REF	Tuolumne River	REF	Merced River	REF
Agricultural	B		B	3c	1.4		2.4	3c	1.4	3c
Mine Drainage			B							
M&I Wastewater (POTW)	B	3a	B		B		B		B	
Urban Runoff	B		A	3b	B		B		B	
Flow Regulation			B							
Refineries	47.7	3d	DNA		B		B		B	
Total	47.7				1.4		2.4		1.4	
									38.1	
									21.8	
										110.8
										3c(1)

3a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

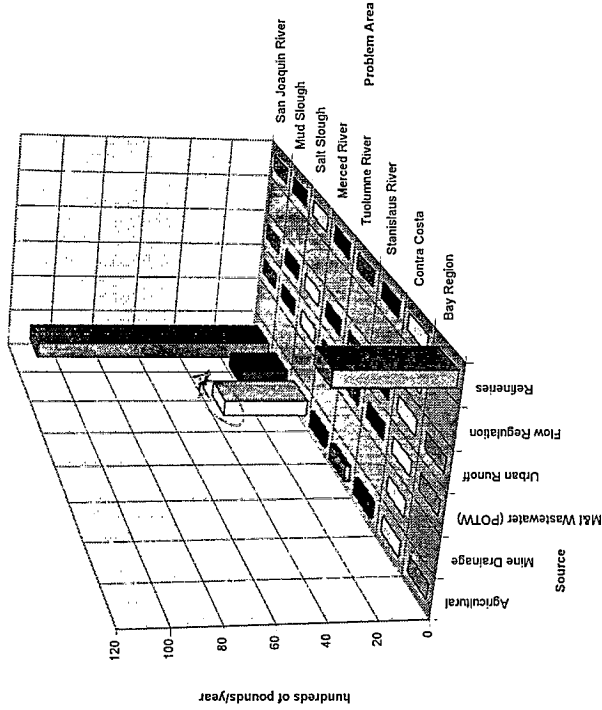
A - Data Available (Flow and concentration data available. Requires load calculation)

B - Further literature review required.

- Source does not contribute significant load of constituent in this watershed.

(1) Average of five stations.

Selenium Loading



## Selenium Loads Study Reference List

**3a.** EPA. 1992. San Francisco Estuary Project State of the Estuary: A Report on Conditions and Problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. (Table 19, pp. 172)

Note: Data from Table 19 was adapted from Davis et al., 1991.

- data reported for Selenium is 2.1 metric tons/year for M&I Wastewater (POTW)

**3b.** Contra Costa Clean Water Program FY 1994-95 Monitoring Report

- Reports Selenium (ug/l) in stormwater runoff.

**3c.** USGS. 1988. Preliminary Assessment of Sources, Distribution, and Mobility of Selenium in the San Joaquin Valley, California. (Referenced in the CALFED Water Quality Technical Group December 1996 Meeting Packet)

- 3c\* = average of low and high-flows at five main tributaries of San Joaquin River
- San Joaquin River calculations are an average of five sites along San Joaquin River (each site is calculated as an average of the reported low and high flows)

**3d.** Taylor, K., Pease, W., Lacy, J., Carlin, M. 1992. Mass Emissions Reduction Strategy for Selenium.

- Adverse ecological effects are primarily caused by selenium in the food chain rather than selenium dissolved in the water column (pg 11)

Refineries:

- average load for 1989-1991 reported as 2162 kg/yr for Selenium (Table 6, pg 39)

M&I Wastewater (POTW)

- High analytical detection limits used in analyses (typically 1ug/l) did not allow for determination of POTW contribution to selenium loading.
- All of POTW effluent discharged into the Bay meets the 5 ug/l water quality objective (pg 40).

**3e.** San Francisco Estuary Institute. Regional Monitoring Program for Trace Substances: 1995 Annual Report.


- Annual Reports published for 1993 and 1994.
- Total Selenium in Water Reported for 24 stations.
- Locations of stations include San Joaquin/Sacramento inflow to South Bay
- Concentration data only.

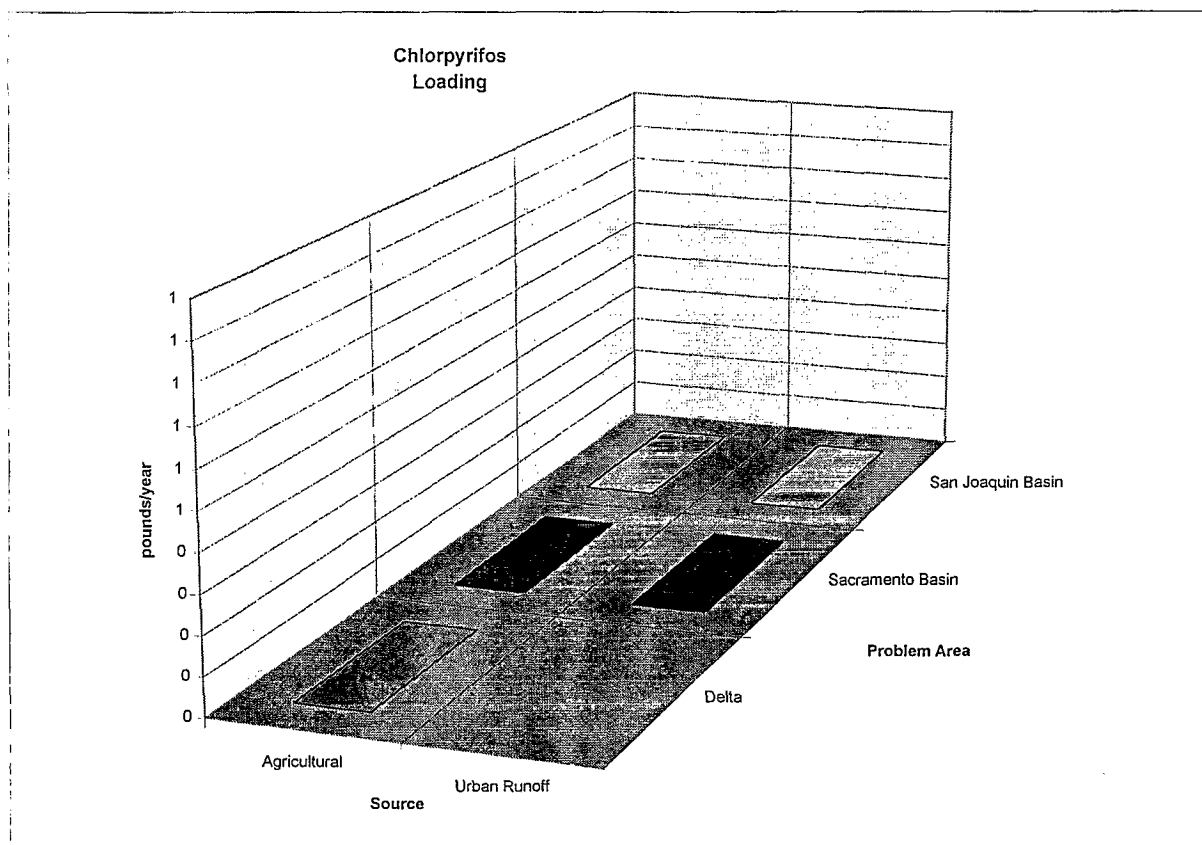
CHLORPYRIFOS LOADING TABLE						
	Chlorpyrifos Loading (pounds/year)					
Source	Delta	REF	Sacramento Basin	REF	San Joaquin Basin	REF
Agricultural	B		A	4c	A	4b,4c,4d,4f
Urban Runoff			A	4e	A	4e
Total						

4a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

A - Data Available (Flow and concentration data available. Requires load calculation)

B - Further literature review required.

 - Source does not contribute significant load of constituent in this watershed.



## **Chlorpyrifos Reference List**

### **General Notes**

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.
- Particle bound compound.

**4a.** San Francisco Estuary Institute. Regional Monitoring Program for Trace Substances: 1995 Annual Report.

- Annual Reports published for 1993 and 1994.
- Sampled 24 stations from Sacramento/San Joaquin inflow to South Bay sloughs. Three sampling events for each year peak winter flow, spring declining flow and summer low flow.
- Concentration data only. Loads could be calculated. Would require acquiring discharge data for Sacramento River, San Joaquin River, Petaluma River, Napa River, and Coyote Creek.

**4b.** USGS. 1995. Nonpoint Sources of Pesticides in the San Joaquin River, California: Input From Winter Storms, 1992-1993. Open File Report 95-165.

- Concentrations data for Orestimba Creek and Merced River for period 27/-2/11, 1993.

**4c.** USGS. 1995. Dissolved Pesticide Data for San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-1994. Open -File Report 95-110.

- Robust sampling frequency. Multiple events each month.
- Concentration data only. Discharge data for sampling locations (Vernalis and Freeport) would need to be compiled.

**4d.** Christopher Foe. Detection of Pesticides in San Joaquin Basin. Central Valley Regional Water Quality Control Board memos 1989-1990.

- Concentration data only. Discharge data would need to be compiled.

**4e.** Valerie Connor. January 1996. Chlorpyrifos in Urban Storm Runoff. Memorandum to Jerry Bruns Central Valley Regional Water Quality Control Board.

- Concentration data from cities of Stockton and Sacramento and the San Francisco Bay Area. Concentration data only. Not known if discharge data can be matched to sampling events/locations.

4f. Department of Pesticide Regulation. 1991-1993. San Joaquin River Study.

- Discharge and concentration data.

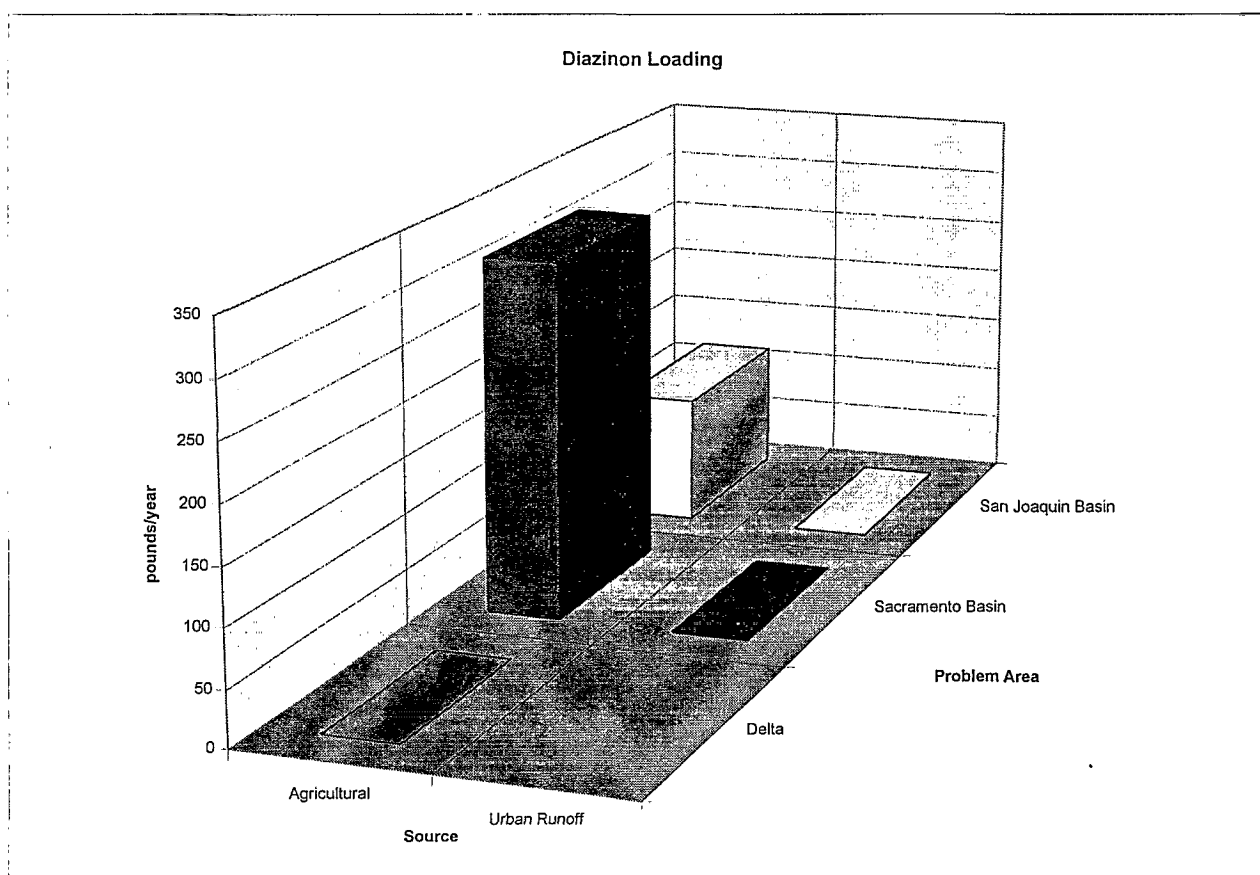
DIAZINON LOADING TABLE						
Diazinon Loading ( pounds/year)						
Source	Delta	REF	Sacramento Basin	REF	San Joaquin Basin	REF
Agricultural	B		319	5h	116	5h
Urban Runoff			A	5e	A	5e
Total	0		319		116	

5a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

A - Data Available (Flow and concentration data available. Requires load calculation)

B - Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



## **Diazinon Reference List**

### **General Notes**

- Applied to almond orchards in January and February and again in May through August.
- Applied to alfalfa fields in March.

#### **5a. San Francisco Estuary Institute. Regional Monitoring Program for Trace Substances: 1995 Annual Report.**

- Annual Reports published for 1993 and 1994.
- Sampled 24 stations from Sacramento/San Joaquin inflow to South Bay sloughs. Three sampling events for each year peak winter flow, spring declining flow and summer low flow.
- Diazinon must be interpreted with caution. No studies of the relative recovery have been undertaken with glass fiber filter/polyurethane foam water sampler used in the RMP since 1993. The values must be considered preliminary until sampling efficiency is documented.
- Concentration data only. Loads could be calculated. Discharge data for Sacramento River, San Joaquin River, Petaluma River, Napa River, and Coyote Creek needs to be compiled.

#### **5b. USGS. 1993. Diazinon Concentrations in the Sacramento and San Joaquin Rivers and San Francisco Bays, California, February 1993. Open File Report 93-440.**

- Daily mean discharge and diazinon concentration for Sacramento Valley and San Joaquin Valley for February 1993.

#### **5c. USGS. 1995. Nonpoint Sources of Pesticides in the San Joaquin River, California: Input From Winter Storms, 1992-1993. Open File Report 95-165.**

- Discharge and Diazinon concentrations for Merced River, Orestimba Creek, and San Joaquin River.

#### **5d. USGS. 1995. Dissolved Pesticide Data for San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-1994. Open -File Report 95-110.**

- Robust sampling frequency. Multiple events each month.
- Concentration data only. Discharge data for sampling locations (Vernalis and Freeport) needs to be compiled.

#### **5e. Valerie Connor. May 10, 1995. Pesticide Toxicity in Urban Storm Runoff. Presentation at Central Valley Regional Water quality Control Board.**

- Concentration data for sampling locations in cities of Stockton and Sacramento.
- Discharge data needs to be compiled.

**5g.** Christopher Foe. Detection of Pesticides in San Joaquin Basin. Central Valley Regional Water Quality Control Board memos 1989-1990.

- Concentration data only. Discharge data needs to be compiled.

**5h.** James Scanlin. 1997. Characterization of Insecticide Use and Presence in the Castro Valley Creek Watershed. Draft Report Alameda County Flood Control and Water Conservation District.

- Load calculations based on concentration and discharge data from the 1995-1996 rainy season.

**5i.** Central Valley Regional Water Quality Control Board. December 1995. Insecticide Concentrations and Invertebrate Bioassay Mortality in Agriculture Return Water.

- Diazinon and chlorpyrifos concentrations from 13 sampling sites in the San Joaquin watershed. Discharge data would need to be compiled.

#### **CALCULATION NOTES:**

Loads were estimated based on measured diazinon concentrations and measured streamflows. Diazinon concentrations in the San Joaquin River at Vernalis were obtained from The USGS WATSTOR database and reference 5d. Diazinon data in the Sacramento River at Sacramento were obtained from reference 5d. Flows in the Sacramento River are from the USGS gage at Freeport (#11447650). Flows in the San Joaquin River are from the USGS gage at Vernalis (#11303500). At Vernalis loads were estimated for years 1991, 1993, and 1994. The average is reported in the table. At Sacramento loads were estimated for 1993 and 1994 and the average reported.

Note, the estimated diazinon load at Sacramento includes urban runoff from Sacramento and surrounding areas in addition to agricultural runoff.

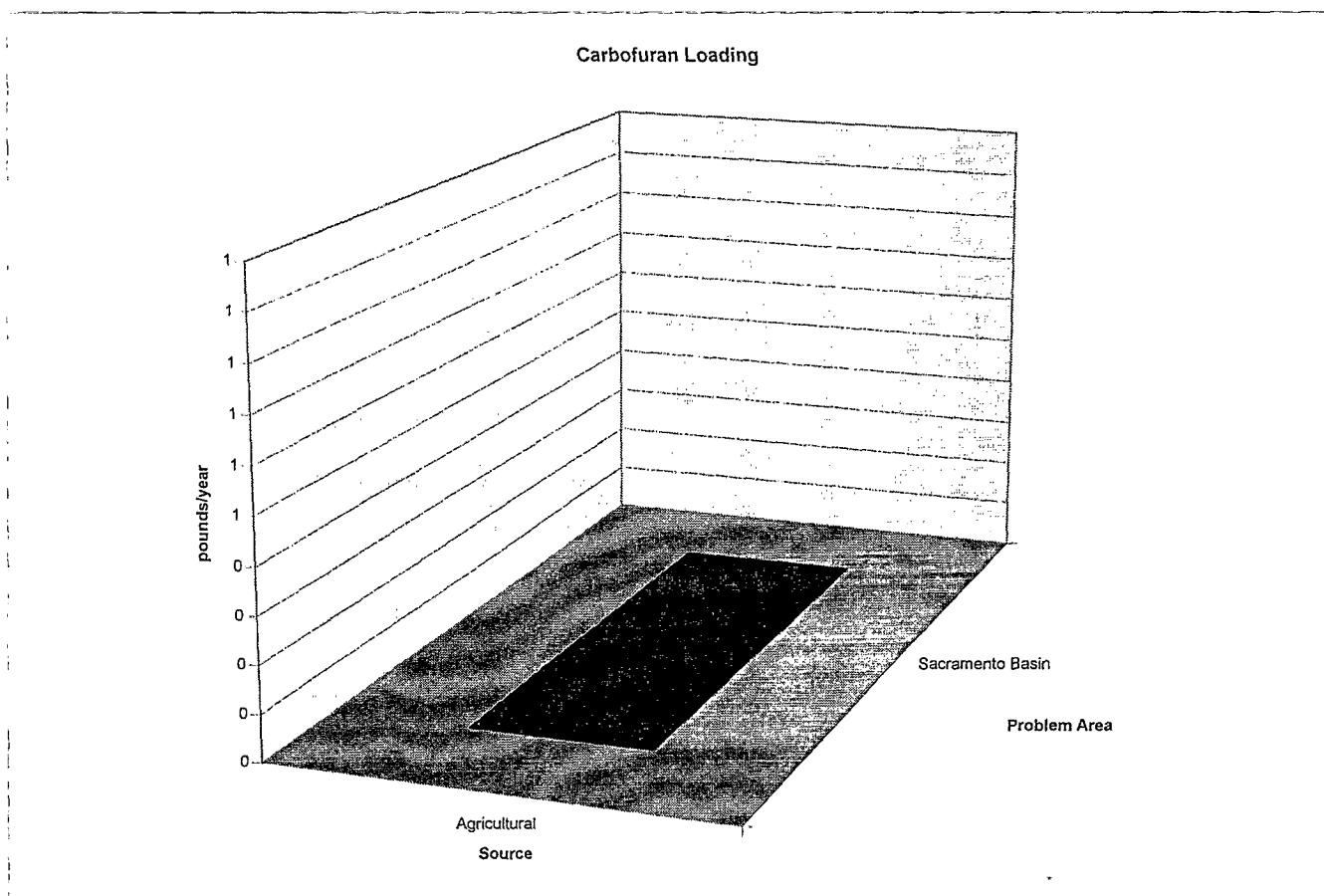
- Non-detect data was not included in the loads analysis.



CARBOFURAN LOADING TABLE		
	Carbofuran (pounds/year)	
Source	Sacramento Basin	REF
Agricultural	A	6a,6b,6c,6d,6e
Total		

6a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

A - Data Available (Flow and concentration data available. Requires load calculation)



## Carbofuran Reference List

### General Notes

- Applied to alfalfa fields in March and to rice fields from April through June.

**6a.** USGS. 1995. Dissolved Pesticide Data for San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-1994. Open -File Report 95-110.

- Robust sampling frequency. Multiple events each month.
- Concentration data for diazinon, carbofuran and chlorpyrifos.
- Concentration data only. Discharge data for sampling locations (Vernalis and Freeport) would need to be compiled.

**6b.** Crepeau, Kathryn, Kuivila, Kathryn and Domagalski, Joseph. Concentrations of Dissolved Rice Pesticides in the Colusa Basin Drain and Sacramento River, California, 1990-1992.

- Sampling each year (1990-1992) during May, June and July.
- Concentration data only. Discharge data for sampling locations (Colusa Basin Drain, Sacramento River, and Rio Vista) would need to be compiled.

**6c.** Department of Fish and Game. Rice Pesticide Concentrations in Sacramento River and Associated Agricultural Drains. Carbofuran monitored from 1987 through 1985.

- Sampling in May through August.
- Concentration data only. Discharge data for Sacramento River and Colusa Basin Drain would need to be compiled.

**6d.** Department of Water Resources. August 1989. The Delta as A Source of Drinking Water: Monitoring Results 1983-1987.

- Concentration data for Barker Slough, Sacramento River at Mallard Island, Lindsay Slough at Hastings, Sacramento River at Greene's Landing, San Joaquin River at Vernalis, Banks Pumping Plant, Delta Mendota Canal, Middle River, Cache Slough, Mokelumne River, American River, Consumnes River, Honker Cut, North Bay Pumping Plant, Clifton Court, Barker Slough and the following agricultural drains Grant Island, Empire Tract, Tyler Island.
- Discharge data for sampling locations would need to be compiled.

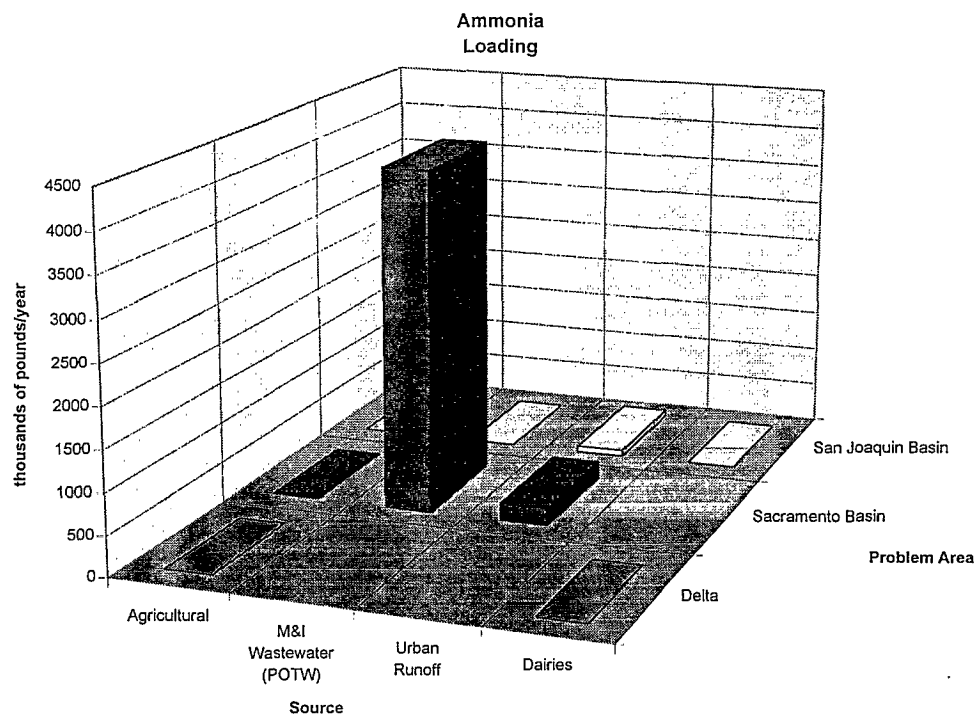
**6e.** Christopher Foe. Detection of Pesticides in San Joaquin Basin. Central Valley Regional Water Quality Control Board memos 1989-1990.

AMMONIA LOADING TABLE						
	Ammonia loading (thousands of pounds/year)					
Source	Delta	REF	Sacramento Basin	REF	San Joaquin Basin	REF
Agricultural	B		B		B	
M&I Wastewater (POTW)			4210	7c	B	
Urban Runoff			208	7a	75	7b,7d
Dairies	B				B	
Other			4679	7c		
Total			9097		75	

7a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

B - Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



## **Ammonia Reference List**

**7a.** Larry Walker & Associates. Sacramento NPDES Stormwater Discharge Characterization Program. 1996 DCP Update Report.

- Wet and dry weather continuous simulation loadings for the Greater Sacramento Urban Watershed.

**7b.** City of Modesto. May 1993. Part 2 NPDES Storm Water Permit Application.

- Method used to calculate loads is analogous to the simple method described in November 1992 EPA Guidance Manual for the Preparation of NPDES Permit application form Municipal Separate Storm Sewers.

**7c.** California Urban Water Agencies. April 1995. Study of Drinking Water Quality in Delta Tributaries.

- Concentration and computed loads for the Sacramento River at Greene's Landing or Freeport.

**7d.** Fresno-Clovis Storm Water Quality Management Program. April 1995. Estimate of Annual Pollutant Loads to Waters of the United States.

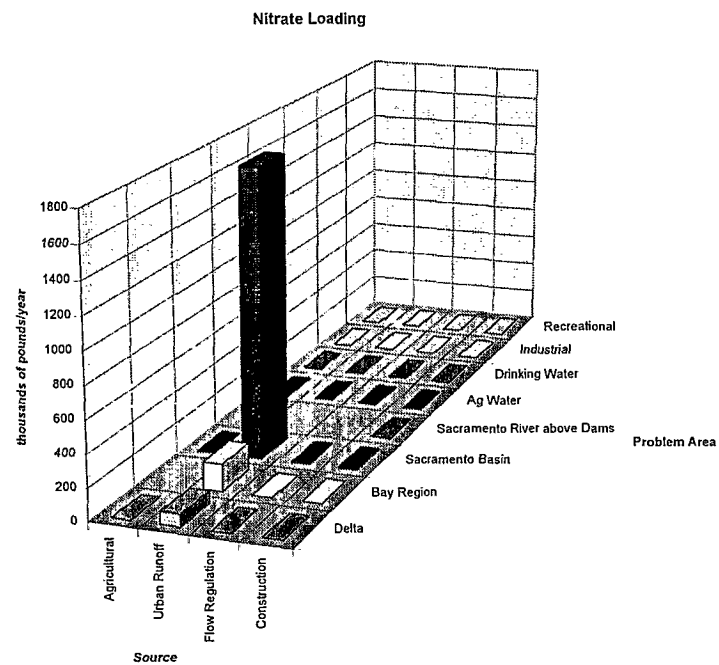
- Method used to calculate loads was derived from the "simple method".

NITRATE LOADING TABLE																
Nitrate Loading (thousands of pounds/year)																
Source	Delta	REF	Bay Region	REF	Sacramento Basin	REF	Sacramento River above Dams	REF	Ag Water	REF	Drinking Water	REF	Industrial	REF	Recreational	REF
Agricultural	B				B				B		B		B		B	
Urban Runoff	77	8a	166	8a	1790	8b			B		B		B		B	
Flow Regulation	B		B		B				B		B		B		B	
Construction	B		B		B		B		B		B		B		B	
Total	77				1790											

8a - Study reference number. Refer to attached list for description of study and summary of key assumptions and methodologies.

B - Further literature review required.

- Source does not contribute significant load of constituent in this watershed.



### **Nitrate Reference List**

**8a.** Contra Costa Clean Water Program. 1994. Contra Costa Clean Water Program Loads Assessment Report.

- Calculated copper and nitrate loads using parcel data and runoff coefficient for each land use.

**8b.** Larry Walker & Associates. Sacramento NPDES Stormwater Discharge Characterization Program. 1996 DCP Update Report.

- Wet and dry weather continuous simulation loadings for the Greater Sacramento Urban Watershed.